

# Crop Coefficients for Estimating Small Grain Water Use, 2003

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## Summary

*Crop coefficients are used to estimate water use from reference evapotranspiration values provided by weather stations. Two varieties of barley and durum were planted at the Maricopa Agricultural Center in late November and early January. Water use was estimated from neutron probe readings and crop coefficients were calculated by dividing water use by reference evapotranspiration. The crop coefficients calculated in this study peaked at 1.0 or less in contrast to published values which generally peak around 1.2. The crop coefficients were lower at the later planting, and there appear to be differences between barley and durum and among barley varieties.*

## Introduction

Crop coefficients are used to calculate water use from weather data. The crop coefficient increases as the crop develops, reaches a peak, and then decreases as the crop senesces. Crop coefficients are most accurate if locally developed using current cropping practices. Crop coefficients have not been developed for Arizona, and we currently rely on values from California or values estimated indirectly from water use work done on outdated varieties by the Water Conservation Research Laboratory in Phoenix in the 1950's and 1960's. We intend to use the crop coefficients developed in Arizona to provide water use estimates for the Small Grain Advisory and for AZSCHED, irrigation scheduling software for Arizona. The purpose of this study is to develop crop coefficients for wheat and barley in Arizona.

## Procedures

Two durum varieties (Kronos and WPB 881) and two barley varieties (Barcott and Baretta) were planted at two dates (Nov 26, 2002 and Jan 3, 2003) at the Maricopa Agricultural Center. The plots were 42 ft by 40 ft in size and replicated twice in a randomized complete block design. Preplant fertilizer included 48 lbs N/acre and 60 lbs P<sub>2</sub>O<sub>5</sub>/acre as 16-20-0. Irrigation was applied at about 50% depletion of plant available water and 248 to 270 pounds of N were applied per acre (Table 1). Water use was estimated in 1 ft depth increments to 4 ft from weekly neutron probe readings. Crop coefficients were calculated by dividing water use by reference evapotranspiration (ET<sub>o</sub>, original AZMET calculation method) from AZMET.

## Results and Discussion

The average maximum temperature for January was the highest on record, and the average minimum temperature for January was also very high (Table 2). Consequently, the crop grew very quickly early in the season, especially the barley. March and April were cooler than average, which promoted a long growing season. Every month of the growing season from December through May received below average rainfall except for February, where rainfall was slightly above average. The weather was very favorable for growth of wheat and barley.

Published values of crop coefficients for barley and wheat peak around 1.2, whereas the values obtained this year peak near 1.0 or less (Table 3). The crop coefficients were lower at the later planting date, and there appear to be differences between durum and barley and among barley varieties.

### Acknowledgements

The technical assistance of Melinda Main is greatly appreciated.

Table 1. Cultural practices for the small grains planted on November 26, 2002 and January 3, 2003.

Cultural practice	November 26, 2002 planting	January 3, 2003 planting
Field	107	107
Border	4 (from south)	2 (from south)
Previous crop	Barley	Barley
Preplant soil NO <sub>3</sub> -N	18.8 ppm	18.8 ppm
Preplant soil P	6.6 ppm	6.6 ppm
Row spacing	7 inches	7 inches
Barley seeding rate	80 lbs/acre	80 lbs/acre
Durum seeding rate	100 lbs/acre	100 lbs/acre
Irrigation and fertilization	11/26 + 48 lbs N/a and 60 lbs P <sub>2</sub> O <sub>5</sub> /a	
	01/29 + 72 lbs N/a	01/03 + 48 lbs N/a and 60 lbs P <sub>2</sub> O <sub>5</sub> /a
	02/27 + 50 lbs N/a	02/27 + 50 lbs N/a
	03/19 + 50 lbs N/a	03/19 + 50 lbs N/a
	04/01 + 50 lbs N/a	04/01 + 50 lbs N/a
	04/11	04/11 + 50 lbs N/a
	04/25	04/25
		05/09
Total N applied	270 lbs N/a	248 lbs N/a

Table 2. Climatic data for Maricopa during the 2003 growing season compared to the long-term average. The rankings of the months in the 18 years of data are from low to high. The climate data was obtained from AZMET.

Climate variable	Unit	Year(s)	Dec	Jan	Feb	Mar	Apr	May	Dec-May
Max Temp. (°F)	Rank of 18	2003	6	18	6	6	4	13	11
	°F	2003	64	73	68	76	82	95	76
	°F	1987-2003	65	66	70	76	85	94	76
Min Temp. (°F)	Rank of 18	2003	14	16	14	6	4	12	14
	°F	2003	37	39	42	43	48	60	45
	°F	1987-2003	35	36	40	44	51	59	44
Ppt. (inches)	Rank of 18	2003	10	9	12	7	9	1	10
	inches	2003	0.43	0.51	1.18	0.24	0.16	0	2.52
	inches	1987-2003	0.82	0.79	0.97	0.94	0.33	0.18	3.98

Table 3. Crop growth stages at various times during the season for the varieties planted at two dates.

Planting date	Date	Crop Growth Stage			
		Barcott	Baretta	Kronos	Westbred 881
Nov 26	Dec 18	2 leaf	2 leaf	2 leaf	2 leaf
	Jan 03	4.2 leaf	4.2 leaf	3.6 leaf	---
	Jan 16	---	6.5 leaf	5.7 leaf	---
	Jan 28	6.75 leaf	7.75 leaf	6.75 leaf	6.75 leaf
	Feb 06	8.75 leaf	8.75 leaf	---	7.75 leaf
	Feb 06	2 nodes	1 node	---	1.5 nodes
	Feb 24	Heading	---	---	---
	Mar 03	---	Flag leaf visible	Late boot	Boot
	Mar 13	---	Late boot	Early heading	Late boot
Jan 03	Feb 24	---	---	6.5 leaf	---
	Mar 13	---	---	---	2 nodes
	Apr 01	Early soft dough	10% heading	75% heading	33% heading

Table 4. Heading, flowering and physiological maturity for the varieties planted at two dates.

Planting date	Stage	Date			
		Barcott	Baretta	Kronos	Westbred 881
Nov 26	Heading	2/22	3/08	3/07	3/07
	Flowering	3/01	3/14	3/18	3/22
	Maturity	4/16	4/30	5/05	5/09
Jan 03	Heading	---	4/05	3/29	4/03
	Flowering	---	---	---	---
	Maturity	5/14	5/18	5/18	5/18

Table 5. Grain yields for the varieties planted at two dates.

Planting date	Grain Yield			
	Barcott	Baretta	Kronos	Westbred 881
	----- lbs/acre -----			
Nov 26	6112	7146	6900	5546
Jan 03	6563	7312	7146	5855

Table 6. Crop coefficients calculated for various growth periods for the two plantings.

Growth period		Barcott	Baretta	Kronos	WB881	Barley	Wheat	All	LSD <sub>.05</sub>
Planted Nov 26									
12/18 - 12/26		0.049	0.225	0.011	-0.032	0.137	-0.010	0.063	NS
12/26 - 01/03		0.222	0.138	0.127	0.135	0.180	0.131	0.156	NS
01/03 - 01/13		0.487	0.438	0.305	0.269	0.462	0.287	0.375	0.121
01/13 - 01/21		0.546	0.621	0.467	0.517	0.583	0.492	0.538	NS
01/21 - 01/28		0.756	0.474	0.647	0.558	0.615	0.603	0.609	NS
02/04 - 02/12		0.681	0.695	0.620	0.653	0.688	0.636	0.662	NS
02/18 - 02/26		0.880	0.790	0.813	0.796	0.835	0.804	0.820	NS
03/05 - 03/13		0.845	0.879	0.680	0.788	0.862	0.734	0.798	0.130
03/13 - 03/18		0.921	1.125	0.891	0.901	1.023	0.896	0.959	NS
03/24 - 04/01		0.941	1.001	0.835	0.888	0.971	0.861	0.916	0.109
04/05 - 04/11		0.628	0.878	0.680	0.688	0.753	0.684	0.718	0.129
04/16 - 04/24		0.486	0.808	0.642	0.698	0.647	0.670	0.658	0.133
04/30 - 05/07		0.438	0.713	0.819	0.948	0.576	0.883	0.730	0.147
05/07 - 05/14		0.404	0.542	0.506	0.573	0.473	0.540	0.506	0.101
05/14 - 05/21		0.399	0.340	0.113	0.151	0.369	0.132	0.251	0.066
05/21 - 05/30		0.283	0.182	0.014	0.017	0.232	0.015	0.124	0.075
Planted Jan 03									
01/30 - 02/06		0.182	0.247	0.167	0.208	0.215	0.188	0.201	NS
02/06 - 02/12		0.344	0.193	0.200	0.225	0.269	0.212	0.240	NS
03/07 - 03/14		0.571	0.648	0.553	0.612	0.610	0.583	0.596	NS
03/24 - 04/01		0.578	0.672	0.587	0.647	0.625	0.617	0.621	NS
04/16 - 04/24		0.839	0.896	0.680	0.688	0.867	0.684	0.776	0.098
04/30 - 05/09		0.561	0.753	0.588	0.596	0.657	0.592	0.625	NS
05/14 - 05/21		0.312	0.520	0.174	0.301	0.416	0.237	0.327	0.124
05/21 - 05/30		0.352	0.138	0.065	0.161	0.245	0.113	0.179	0.136